

WHAT IS CLAIMED IS:

1. An apparatus for generating a hydrogen-rich reformat, the apparatus comprising:
 - 5 a reactor comprising a catalyst bed, the catalyst bed comprising a reforming catalyst suitable for converting a hydrocarbon fuel to a reformat comprising hydrogen and carbon dioxide, and a carbon dioxide fixing material suitable for fixing within the catalyst bed at least a portion of the carbon dioxide in the reformat to provide an intermediate reformat;
 - 10 and
 - a first purification bed in fluid communication with the reactor for receiving the intermediate reformat, the first purification bed comprising a hydrogen fixing material suitable for fixing at least a portion of the hydrogen in the reformat to provide a hydrogen-depleted gas and fixed
 - 15 hydrogen.
2. The apparatus of claim 1, further comprising a desulfurization unit disposed upstream of the reactor for removing sulfur-containing compounds from the hydrocarbon fuel.
- 20 3. The apparatus of claim 1, wherein the catalyst bed further comprises a water gas shift catalyst.
4. The apparatus of claim 1, wherein the reforming catalyst and carbon dioxide fixing material have a non-uniform distribution within the catalyst bed.
- 25 5. The apparatus of claim 1, wherein the reactor further comprises heat exchanging means for delivering heat to and/or removing heat from the carbon dioxide fixing material.
- 30 6. The apparatus of claim 1, wherein the first purification bed further comprises a first heat exchanging means for delivering heat to and/or removing heat from the hydrogen fixing material.

7. The apparatus of claim 1, wherein the first purification bed further comprises a vessel having an inlet, an outlet and a gas passage extending from the inlet to the outlet, the hydrogen fixing material disposed within the gas passage.
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8. The apparatus of claim 1, wherein the hydrogen fixing material comprises a metal hydride-forming material.
9. The apparatus of claim 1, wherein the first purification bed further comprises an inert material having a high heat capacity.
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10. The apparatus of claim 1, further comprising a polishing unit disposed upstream from the first purification bed for removing one or more impurities from the intermediate reformat.
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11. The apparatus of claim 10, wherein the polishing unit is a drying unit for removing water from the intermediate reformat.
12. The apparatus of claim 10, wherein the polishing unit is a methanation reactor.
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13. The apparatus of claim 1, further comprising a hydrogen storage device disposed downstream in fluid communication with the first purification bed.
14. The apparatus of claim 1, further comprising a controller for controlling the operation of the reactor and/or the first purification bed.
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15. The apparatus of claim 1, further comprising a second purification bed and a manifold disposed downstream of the reactor for diverting reformat between the first purification bed and the second purification bed.
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16. The apparatus of claim 6, further comprising a second purification bed and a second heat exchanging means disposed within the second purification bed, the

first and second heat exchanging means operably connected with each other so as to provide heat transfer between the first and second purification beds.

- 5 17. A method for generating a hydrogen-rich reformat, the method comprising the steps of:
- reacting a hydrocarbon fuel in a catalyst bed comprising a reforming catalyst and carbon dioxide fixing material to produce a reformat comprising hydrogen and carbon dioxide, the carbon dioxide fixing material fixing at least a portion of the carbon dioxide in the reformat to produce an
10 intermediate reformat;
- removing hydrogen from the intermediate reformat by flowing the intermediate reformat through a first purification bed comprising a hydrogen fixing material to produce a hydrogen-depleted gas and fixed hydrogen; and
15 releasing the fixed hydrogen from the first purification bed to produce a hydrogen-rich gas.
18. The method of claim 17, further comprising removing water from the intermediate reformat prior to flowing the intermediate reformat through the
20 first purification bed.
19. The method of claim 17, further comprising methanating the intermediate reformat prior to flowing the intermediate reformat through the first purification bed.
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20. The method of claim 17, wherein the catalyst bed further comprises a water gas shift catalyst.
21. The method of claim 17, wherein removing hydrogen from the intermediate reformat further comprises removing heat from the first purification bed.
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22. The method of claim 17, further comprising the step of monitoring the composition of the hydrogen-depleted gas.

23. The method of claim 17, further comprising the step of interrupting the flow of intermediate reformat through the first purification bed.
- 5 24. The method of claim 17, further comprising the step of purging the first purification bed to remove hydrogen-depleted gas prior to releasing the fixed hydrogen.
- 10 25. The method of claim 17, wherein the hydrogen fixing material comprises a metal hydride-forming material.
- 15 26. The method of claim 17, wherein fixed hydrogen is released from the first purification bed by imposing a change in temperature, pressure or a combination of changes in temperature and pressure on the hydrogen fixing material.
- 20 27. The method of claim 17, further comprising the steps of diverting the intermediate reformat from the first purification bed and flowing the intermediate reformat through a second purification bed comprising a hydrogen fixing material to produce a hydrogen-depleted gas and fixed hydrogen.
- 25 28. The method of claim 27, wherein fixed hydrogen is released from the first purification bed while the intermediate reformat flows through the second purification bed.
- 30 29. The method of claim 27, wherein fixed hydrogen is released from the first purification bed by heating the hydrogen fixing material within the first purification bed with heat derived at least in part from the second purification bed.
- 30 30. The method of claim 27, further comprising the step of releasing fixed hydrogen from the second purification bed by imposing a change in temperature, pressure or a combination of changes in temperature and pressure on the hydrogen fixing material in the second purification bed.